8. (New) The apparatus according to claim 7, wherein each of said blocks includes therein a heating wire and a temperature sensor for detecting the temperature of each block.

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9. (New) The apparatus according to claim 7, wherein said heating blocks are arranged in a vertical direction so that one heating block is disposed adjacently above another heating block.

REMARKS

The instant case is a divisional application directed to the subject matter of original claim 4, a claim not elected for examination in the parent case following the election of species requirement mailed June 1, 2000. Claim 4 has been rewritten as new claim 7 to read in more conventional U.S. patent format. Dependent claims 8 and 9 have been added directed to particular embodiments of the invention.

The specification has been revised as in the parent case. One additional minor correction has been made.

An Information Disclosure Statement is being filed also.

The Examiner is referred to Figs. 25 and 26 and related discussion in the specification for the claimed subject matter.

An early examination of claims 7 to 9 is earnestly solicited.

Respectfully submitted,

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May 29, 2001
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molded resin article.

In this method, however, when the pattern-bearing film is sucked to the heating board, air is caught between the heating board and the pattern-bearing film. This air remains as air bubbles so that the pattern-bearing film is not uniformly heated. In addition, marks or impressions of vacuum holes defined on the heating board remain on the surface of the final molding having the pattern-bearing film sucked thereby. Thus, the appearance of the molding is adversely affected.

To solve this problem, a method as disclosed in Japanese Patent Laid-Open Publication Serial No. HEI 5-301250 (i.e., Japanese Patent Application Serial No. HEI 4-108271) has been proposed. In this method, a square-shaped holding flame is protruded from a peripheral edge of the heating surface of the heating board so as to contact with the pattern-bearing film, and a concave portion is formed at the inside of the annular holding frame. When the pattern-bearing film is located to be opposed to the heating board in order to heating the film, the concave portion prevents the film from directly contact with the heating surface of the heating board. Thus, the concave portion restrains the marks or impressions of vacuum holes from being formed on the surface of the final molding so that the appearance of the molding is fortunately affected.

In the above method, however, while the pattern-bearing film is heated by the heating board so as to be softened, the film is transferred into the internal surface of the female mold so as to be positioned thereto. At this state, slacks or wrinkles are liable to be formed on the film and the positioning of the film cannot be accurately performed by the effect of the softened film.

Summary of the Invention

The present invention is made from the above-mentioned point of view. A first object of the present invention is

to provide a method for forming a pattern onto an article during an injection molding thereof and an apparatus for the same, in which the pattern-bearing film can be transferred to a position opposed to the internal surface of the female mold under the condition that the slacks or wrinkles are not formed on the film, so that the pattern-bearing film can be accurately positioned to the internal surface of the female mold.

A second object of the present invention is to provide an apparatus for forming a pattern onto an article during an injection molding thereof and an apparatus for the same, in which the heating board can be simply and securely pressed into the female mold.

A third object of the present invention is to provide an apparatus for forming a pattern onto an article during an injection molding thereof and an apparatus for the same, in which the heating board can be securely pressed into the parting surface of the female mold.

A fourth object of the present invention is to provide an apparatus for forming a pattern onto an article during an injection molding thereof and an apparatus for the same, in which the heating board can uniformly heat the entire pattern-bearing film.

A fifth object of the present invention is to provide an apparatus for forming a pattern onto an article during an injection molding thereof and an apparatus for the same, in which a insulation board waiting at a standby position can prevent the pattern-bearing film or the like from being heated and deformed in the standby position.

A sixth object of the present invention is to provide an apparatus for forming a pattern onto an article during an injection molding thereof and an apparatus for the same, in which the pattern-bearing film can be cut by a simple structure and the cutting is lower in cost.

According to one aspect of the present invention, the first object is accomplished by a method for forming a

Fig. 14 is an explanation view showing a step next to the step of Fig. 13;

Fig. 15 is a side view schematically showing the overall construction of an apparatus for forming a pattern onto an article during an injection molding thereof according to a second embodiment of the present invention;

Fig. 16 is a perspective view of the female mold shown in Fig. 15;

Fig. 17 is an explanation view a first step of the operation according to the second embodiment;

Fig. 18 is an explanation view a second step of the operation according to the second embodiment;

Fig. 19 is an explanation view a third step of the operation according to the second embodiment;

Fig. 20 is a cross-sectional view schematically showing the overall construction of an apparatus for forming a pattern onto an article during an injection molding thereof according to a third embodiment of the present invention;

Fig. 21 is an explanation view a step of the operation different from the step shown in Fig.20;

Fig. 22 is a perspective view of the female mold shown in Fig.20;

Fig. 23 is a perspective view schematically showing the construction of an apparatus for forming a pattern onto an article during an injection molding thereof according to a fourth embodiment of the present invention;

Fig. 24 is a side view of the male and female molds shown in Fig. 23;

Fig. 25 is a side view of a modification of the heating board; and

Fig. 26 is a cross-sectional view of the heating board shown in Fig. 25.

Detailed Description of the Preferred Embodiments

FIG. 1 is a side view schematically showing the overall construction of an apparatus for forming a pattern onto an

article during an injection molding thereof. A male mold 1 is fixed on a mounting board 3. The male mold 1 is opposed to a female mold 2. An injection nozzle 5 is arranged on the male mold 1 to communicate with an injection gate 4. The female mold 2 is fixed to a ram 7 through a movable board 6. With forward and backward traveling operation of the ram 7, the female mold 2 advances to and retreats from the male mold 1. In addition, the female mold 2 is provided with an air exhaust hole 8 through which air in the female mold 2 is exhausted to the outside by a vacuum pump (not shown in the figure). An fitting groove 1a in a shape of a rectangle is formed on a parting surface of the male mold 1, and another fitting groove 2b in a shape of a rectangle is formed on a parting surface of the female mold 2 so as to be opposed to the fitting groove 1a.

At a position spaced apart from the outer peripheries of the male mold 1 and the female mold 2 by a predetermined distance, a heating board 9 is disposed. The position where the heating board 9 is disposed will hereinafter be referred to as the standby position. On the other hand, the position where the male mold 1 and the female mold 2 are opposed and the heating board 9 is moved therebetween will hereinafter be referred to as the loading position. The heating board 9 can be laterally travelled between the standby position and the loading position by a drive means (not shown in the figure).

A pattern-bearing film X is drawn from a roll R in a direction of an arrow shown in Fig. 1 by means of chuck devices 34 and 34 so that the film X is fed to a position opposed to the female mold 2, as described in later.

Figs. 2 and 3 show the construction of the heating board 9 in detail.

The heating board 9 has a stacked structure of a heating plate 10, a liner plate 11, a heater panel 12, and an insulation plate 13 which are stacked in this order. As

described in later, the heating plate 10 heats the pattern-bearing film X. A holding frame 14 in a shape of a rectangle is provided on the front surface of the heating plate 10. The heating board 9 is mounted to a support member 15 so as to be moved by solenoids 16. With the operation of the solenoids 16, the heating board 9 is moved in the direction perpendicular to the pattern-bearing film X. The solenoids 16 cause the heating board 9 to advance to and retreat from the female mold 2.

The heating plate 10 of the board 9 is made of a metal with high heat transfer characteristic. In the area where the heating plate 10 is surrounded by a peripheral wall 14a of the holding frame 14, a large number of small air blowing holes 17 are formed in an array at intervals of a predetermined pitch. The air blowing holes 17 pass from the front to rear surfaces of the heating plate 10. With the heating plate 10 and the peripheral wall 14a of the holding frame 14, a recess 14b is formed as also shown in FIG. 5. When a ceramic layer is formed on the front surface of the heating plate 10, radiant heat efficiency will be improved. The liner plate 11, which is disposed behind the heating plate 10, is composed of a metal plate with a high heat transfer characteristic. The liner plate 11 has a surface which is in contact with the rear surface of the heating plate 10. The surface has grooves 18 distributed therein through which compressed air is supplied to the air blowing holes 17. An air passageway 19 is provided at the center of the liner plate 11. The air passageway 19 passes through the liner plate 11. The air passageway 19 also passes through the center of the heater panel 12 and the insulation plate 13. The air passageway 19 is open at the rear surface of the insulation plate 13. The open portion of the air passageway 19 is connected to an air hose 20. The air hose 20 can be connected to either a low pressure compressor 22 or a high pressure compressor 23 by a three-way switching valve 21.

disposed outside the region of the male mold 1 and the female mold 2 to a position opposed to the female mold 2 with the pattern-bearing film X therebetween , as shown in Fig.7. Thereafter, the suppressing frame 32 is adjusted to coincide with the fitting groove 2b on the parting surface of the female 2. The groove 2b is defined so that it surrounds the cavity surface.

Next, as shown in FIG. 8, the film suppressing frame 32 is pressed into the fitting groove 2b with the pattern-bearing film X interposed therebetween. Thus, the pattern-bearing film X is contacted to the parting surface of the female mold 2. At this point, it is preferred that the outer surface of the film suppressing frame 32 is level with the parting surface of the female mold 2 after the fitting is completed. However, as shown in the figure, when a groove 1a for fitting the film suppressing frame 32 is formed on the peripheral portion of the male mold 1 so that it is opposed to the fitting groove 2b of the female mold 2, it is not necessary to cause the outer surface of the film suppressing frame 32 to be level with the parting surface. Rather, the film suppressing frame 32 may protrude so that a peripheral portion 14a of the holding frame 14 can be easily pressed. FIG. 9 is a front view of the female mold 2 seen from the left in FIG. 8. As shown in Fig. 9, the film suppressing frame 32 has a connection portion 32 connected to a driving source disposed on the side thereof.

Next, as shown in FIG. 10, the heating board 9 at the standby position is moved to the front surface of the female mold 2. Thereafter, by the peripheral wall 14a of the holding frame 14 on the heating board 9, the pattern-bearing film X is pressed through the film suppressing frame 32. At this stage, the pattern-bearing film X is brought in contact with the peripheral wall 14a of the holding frame 14. Thus a closed heating space is defined, and the pattern-bearing film X is heated in a

non-contact state. After the pattern-bearing film X is satisfactorily softened, as shown in FIG. 11, it is subjected to a vacuum suction through the air exhaust hole 8. When necessary, together with the vacuum suction, an air may be blown toward the pattern-bearing film X through the air blowing hole 17. Thus, the pattern-bearing film X is caused to accord to the contour of the cavity surface 2a.

Thereafter, as shown in FIG. 12, the heating board 9 is retreated to the standby position. Next, the female mold 1 and the male mold 2 are clamped. A molten resin is injected from the injection gate 4 so that the cavity is filled therewith.

After the molten resin is cooled and solidified, as shown in FIG. 13, the male mold 1 and the female mold 2 are opened and then the film suppressing frame 32 is separated from the film suppressing frame fitting groove 2b on the female mold 2. Thus, a final resin molding which is adhered to the pattern-bearing film X is taken out. When the pattern-bearing film X is a transfer printing film, only the substrate film is peeled off with the pattern being left on the final molding.

In another example of the method of opening the mold, after the molten resin has been cooled and solidified, as shown in FIG. 14, the film suppressing frame 32 is moved from the fitting groove 2b of the female mold 2 into the fitting groove 1a of the male mold 1. After the pattern-bearing film X is released, the mold opening operation shown in FIG. 13 may be performed. In this method, the molding may be more easily taken out from the male mold 1 and the female mold 2.

An effect intrinsic to the above-described embodiment is that since the pattern-bearing film X is fixed directly on the parting surface of the female mold and is thereafter heated and softened, deformation and displacement seldom take place on the pattern-bearing film X. In particular,

38, and at the same time the feeding roller 42 is reversely rotated. Thus, the film X is tightened so that the slacks or wrinkles can be removed. Thereafter, the sliding rods 36 are retreated, as shown in Fig. 19, so that the film suppressing frame 32 is pressed into the fitting groove 2b with the film X interposed therebetween. The state shown in Fig. 19 corresponds with that shown in Fig. 8 of the first embodiment.

Processes after the state shown in Fig. 19 corresponds with the processes shown in Figs. 10 to 14, and a final resin molding on which a pattern is formed during the injection is removed from the molds. Also, in this embodiment, the insulation board 43 is located opposite to the heating surface of the heating board 9 waiting on the standby position shown in Fig. 15. Therefore, the insulation board 43 prevents the heat radiated from the heating board 9 from excessively heating the pattern-bearing film before forming, the forming apparatus and so forth, whereupon this restrains melting, deformation, fire and so forth of the pattern-bearing film.

Now, with reference to Figs. 20 to 22, a third embodiment of the present invention will be described. Figs. 20 and 21 are sectional views of the apparatus taken along a lateral line, respectively. As shown in Figs. 20 to 22, two pairs of members 50 for holding heating board 9 are arranged along the both sides of the female mold 2 and the movable board 6 so as to advance thereto and retreat therefrom. Each holding member 50 is formed in a shape of U letter, and a pair of holding members 50 have a pair of openings opposed to each other. Each holding member 50 is reciprocated through a operating rod 53 driven by driving device 52 such as an air cylinder.

The pattern-bearing film X is fed so as to cover the entire parting surface of the female mold 2, and then, as shown in Fig. 20, the film suppressing frame 32 is pressed into the fitting groove 2b with the film X interposed

therebetween, that is, the film X is fixed in the same state as shown in Fig. 8. In this state, the heating board 9 is advanced to the loading position opposed to the female mold 2, and the holding members 50 are located in [a] advanced position shown in Figs. 20 and 22. Thereafter, the heating board 9 is inserted into a space between a pair of holding members 50. In order to facilitate the insertion, a pair of holding members 50 should be located apart from each other so as to hold both ends of the heating board 9, and should have [a] internal distance so as to slidably accommodate the heating board 9.

In the state shown in Fig. 20, holding members 50 are advanced to the left in Fig. 20 (a male direction) by the driving device 52, whereupon the heating board 9 is apart from the female mold 2. In this state, the driving device 52 causes the operating rods 53 to move to the right of Fig. 21, that is, a direction of the arrow shown in Fig. 21. Thus, the heating board 9 held by the holding members 50 are retreated to the female mold 2, and then holding frame 14 disposed in front of the heating member 9 are brought into contact with the film suppressing frame 32. When the air in the cavity 2a is sucked through the exhaust hole 8, the pattern-bearing film X which is spread around the openings of the cavity 2a is sucked to the internal surface thereof. This state is shown in Fig. 21. The processes after this state corresponds with the processes of the first and second embodiments so that the description thereof will be omitted.

According to the third embodiment, the heating board is held or surrounded by the holding members provided on the female mold so that the heating board is intensely pressed to the female mold. Even if the compressed air is blown from the heating board at the vacuum formation, the holding members prevent the heating board from being apart from or removed from the female mold. The driving device can be miniaturized, as compared that the heating board is pressed